
INTRASPECIFIC VARIATION IN *PAVETTA RIGIDA* (RUBIACEAE): ESTIMATES OF RELIABILITY OF TAXONOMIC INFORMATION

Variations in number of flower buds per inflorescence, number of inflorescences per plant, approximate plant height, leaf blade length and width ranges, number of secondary lateral leaf veins, and leaf length/width ratio are analyzed for a sample of 11 plants of *Pavetta rigida* near Lake Barumbi Mbo, Southwest Province, Cameroon. Lowest prevalence of bacterial leaf nodules is noted to coincide with lowest flower number among plants sampled. *Pavetta rigida* provides quantified evidence that, for purposes of plant identification, ranges of variation in individuals being identified and ranges of variation in keys and descriptions based on one or few collections can often be doubled in attempts to fit specimens being identified into existing taxonomic groups.

Pavetta L. (Rubiaceae subfamily Ixoroideae) is a paleotropical genus of ca. 400 species, mostly forest shrubs, having four-merous flowers, nonre-curved stigmas, and the "Ixoroid" pollination mechanism sensu Bremekamp (1934) and Robbrecht (1988). Eleven individuals of *P. rigida* Hiern subg. *Pavetta* were found in flower bud shortly before anthesis near a path around the perimeter of Lake Barumbi Mbo near Kumba, Southwest Province, Cameroon, inside the crater containing the lake. The distance between the farthest apart of the 11 individuals was estimated to be ca. 1 km straight line distance or nearly $\frac{1}{4}$ of the circumference of the lake. The nearest two individuals were separated by ca. 10 m.

METHODS

Field recordings of the ranges of variation in the following characters were made from April 18 through April 23: numbers of flower buds per inflorescence in inflorescences nearing anthesis, numbers of inflorescences per plant, approximate plant heights, leaf blade lengths and widths, and numbers of lateral veins on one side of leaf midribs. Leaf length/width ratios were calculated later. Ranges and midranges of character states for in-

dividual plants, and the resulting total range in the plants studied, were determined from the data in Figure 1. The mean per-plant range was determined for each character and compared with the total range for the 11 plants in the study. Comparisons of the ranges of variation observed in this study were then made with earlier species descriptions of *P. rigida* (Hiern, 1877; Bremekamp, 1934).

RESULTS FOR QUANTITATIVE CHARACTERS

Raw data are shown in Figure 1. Overall ranges, as well as means and standard deviations of the individual plant midranges, are presented in Table 1. Mean per-plant ranges are expressed as percentages of the total range of the 11 plants in Table 2. The comparisons of ranges of variation observed in this study with earlier species descriptions are presented in Table 3. Results presented in the figure and tables not thought to be self-explanatory are discussed below.

NUMBER OF FLOWER BUDS PER INFLORESCENCE

Flower buds were counted on each inflorescence nearing anthesis on each of the 11 plants. Three plants had one such inflorescence, seven had two such inflorescences, and one had four such inflorescences. The mean of the midranges in number of flowers per inflorescence on each individual of 82.4 buds and standard deviation of 32.6 buds (Table 1) do not fully express the pattern of variation in this character. Of the 11 plants, five had all inflorescences nearing anthesis with 86–124 flower buds, five had all with 50–72 buds, and one had all with 19–41 buds. The 11 plants can thus be divided into three nonoverlapping groups with regard to number of flowers per inflorescence. If the original species description had included number of flowers per inflorescence and had been based on any one of these plants, the probability that the

TABLE 1. Total character state ranges, means, and standard deviations in 11 individuals of *Pavetta rigida*.

Character	Range	Mean of mid-ranges for individual plants	Standard deviation of mid-ranges for individual plants
Number of buds per inflorescence	19-124	82.4	32.6
Number of inflorescences per plant	1-5	—	—
Number of lateral veins ¹	6-15	9.6	1.0
Leaf blade length, cm	14-48	29.0	3.2
Leaf blade width, cm	5-17	11.5	1.4
Leaf blade length/width ratio	2.1-3.2	2.6	0.4
Plant height, m	1.0-2.5	—	—

¹ Only 10 plants scored for this character.

second plant found, even if in the same area, would have matched the description would have been less than 0.5. The original description (Hiern, 1877) did not mention this character and Bremekamp (1934), in his monograph of *Pavetta*, indicated flowers to be "circ. 100."

NUMBER OF INFLORESCENCES PER PLANT

As seen in Figure 1, almost two-thirds of the plants bore two inflorescences. Nearly, but not quite all, of the inflorescences were nearing anthesis.

NUMBER OF LATERAL VEINS ON ONE SIDE OF MIDRIB

Lateral veins included in these counts are only those veins originating at the midrib and extending

all the way to a submarginal position on the leaf blades and larger in diameter than other veins originating from the midrib—i.e., secondary veins sensu Hickey (Hickey, 1973) originating from the midrib. This character was determined for each of 10 individuals.

LEAF BLADE LENGTH/WIDTH RATIO

This ratio was determined for each of the 11 plants as the midrange of leaf blade lengths divided by the midrange of leaf blade widths. The within-plant ratios so determined were scored to find the overall range in leaf length/width ratios.

PLANT HEIGHT

Plant height was estimated to the nearest 0.25 m.

COMPARISON WITH EARLIER SPECIES DESCRIPTIONS

As shown in Table 3, earlier species descriptions encompass considerably less than the complete range of variation revealed by measurements of 10 or 11 plants in all characters for which there are comparable data; the present study of 11 individuals failed to detect the complete range of variation known in plant height and leaf blade length.

OBSERVATION OF FEWER FLOWERS ON PLANT WITH PAUCITY OF BACTERIAL NODULES

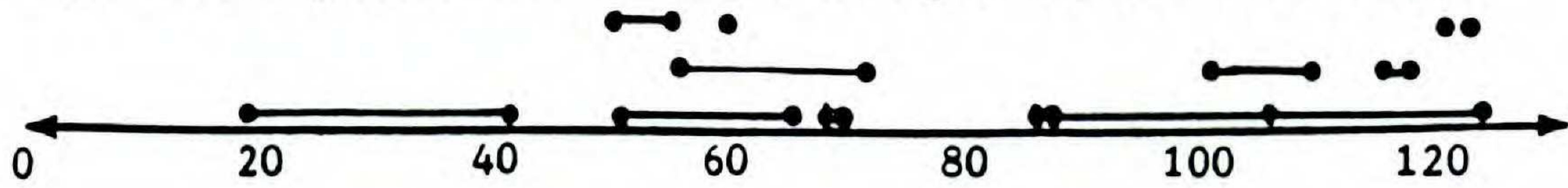
The one plant (voucher: *Manning 1777 MO*) whose two inflorescences had the least flowers (41 and 19) was also the plant with least extensive leaf growths, termed bacterial nodules (Bremekamp, 1934; Lersten & Horner, 1976) or leaf galls (Robbrecht, 1988), characteristic of most *Pavetta* species. These growths were not prevalent on the plant and individual leaves sometimes lacked them, unlike all the other individuals in this survey. This

TABLE 2. Ranges of variation in individual plants compared to total range of variation in 11 plants.

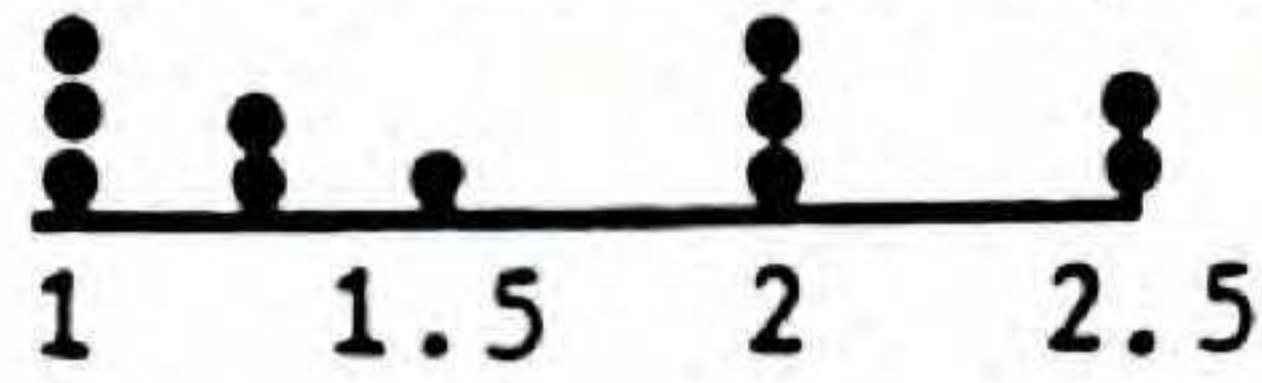
Character	Range of ranges in individuals	Mean range per individual	Total range of 11 plants	Mean % of total range per individual
Number of buds per inflorescence ¹	1-38	13.5	105	13
Number of lateral veins	3-7	5.3	10	53
Leaf blade length, cm	10-29	17.9	34	53
Leaf blade width, cm	4.5-11	6.6	12	55

¹ Only eight plants were included for this character because the other three had only one near-anthesis inflorescence each.

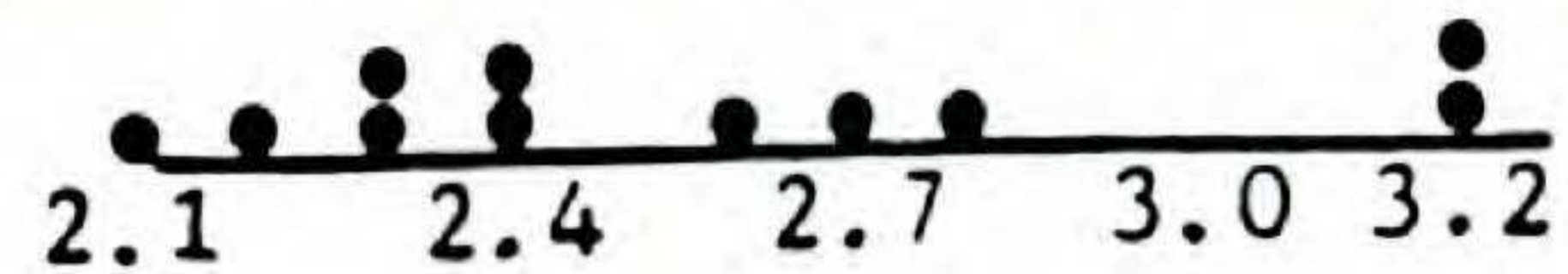
A. Numbers of flower buds per inflorescence. Inflorescences on the same plant are connected by horizontal lines.



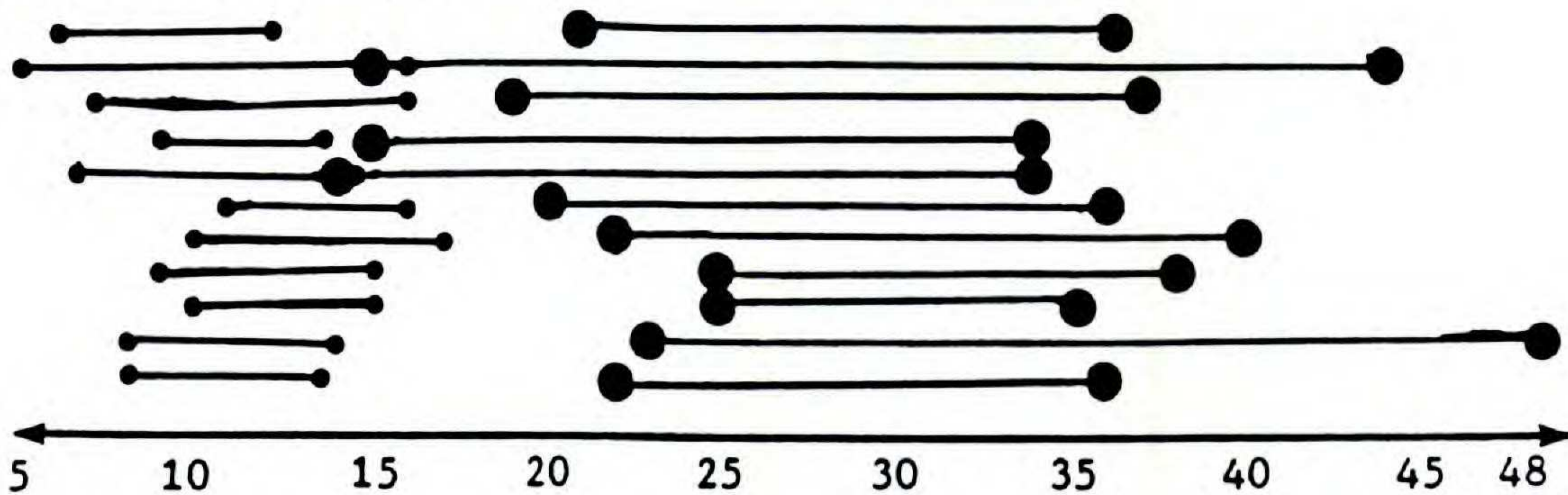
B. Plant heights, m.



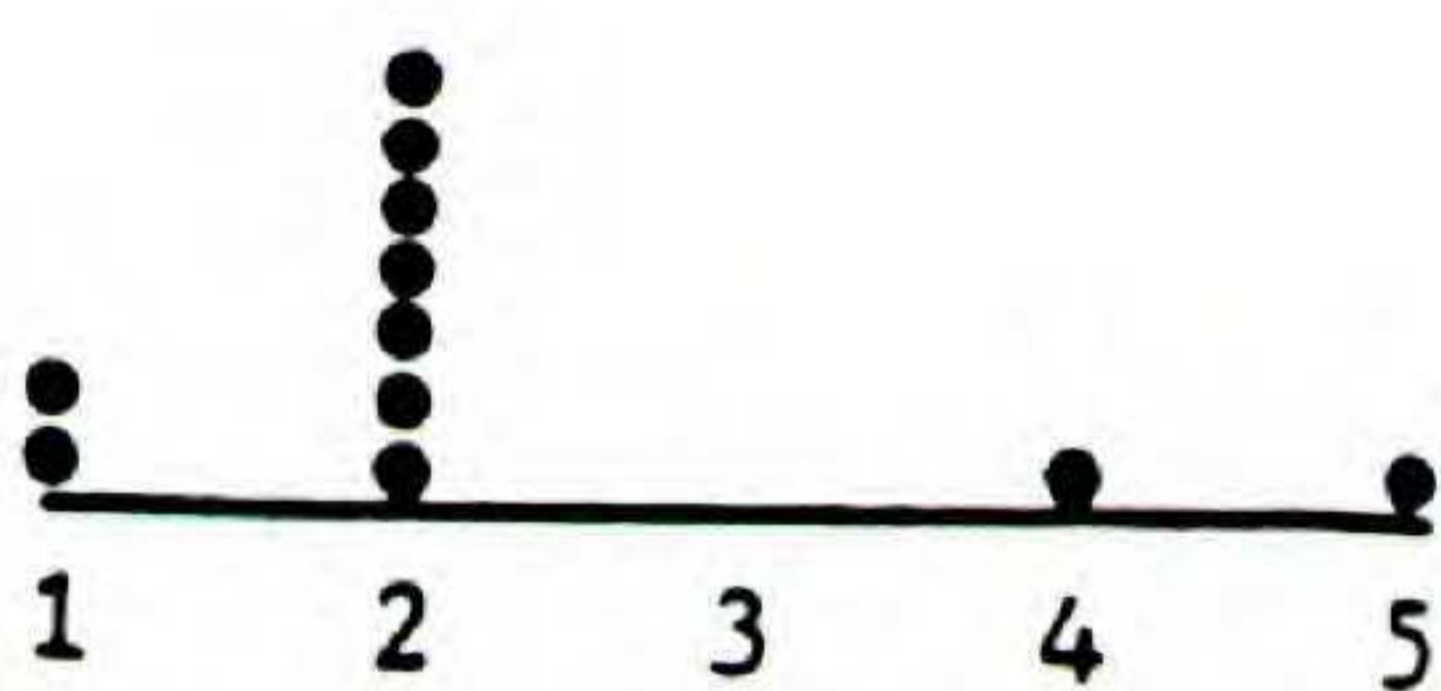
C. Leaf length/width ratios



D. Leaf lengths (●—●) and widths (●—●). Each horizontal line represents the range in length or width for one individual in cm. Length and width ranges are shown side by side for each individual.



E. Numbers of inflorescences per plant



F. Ranges in numbers of lateral veins on one side of midrib. Each horizontal line represents one individual.

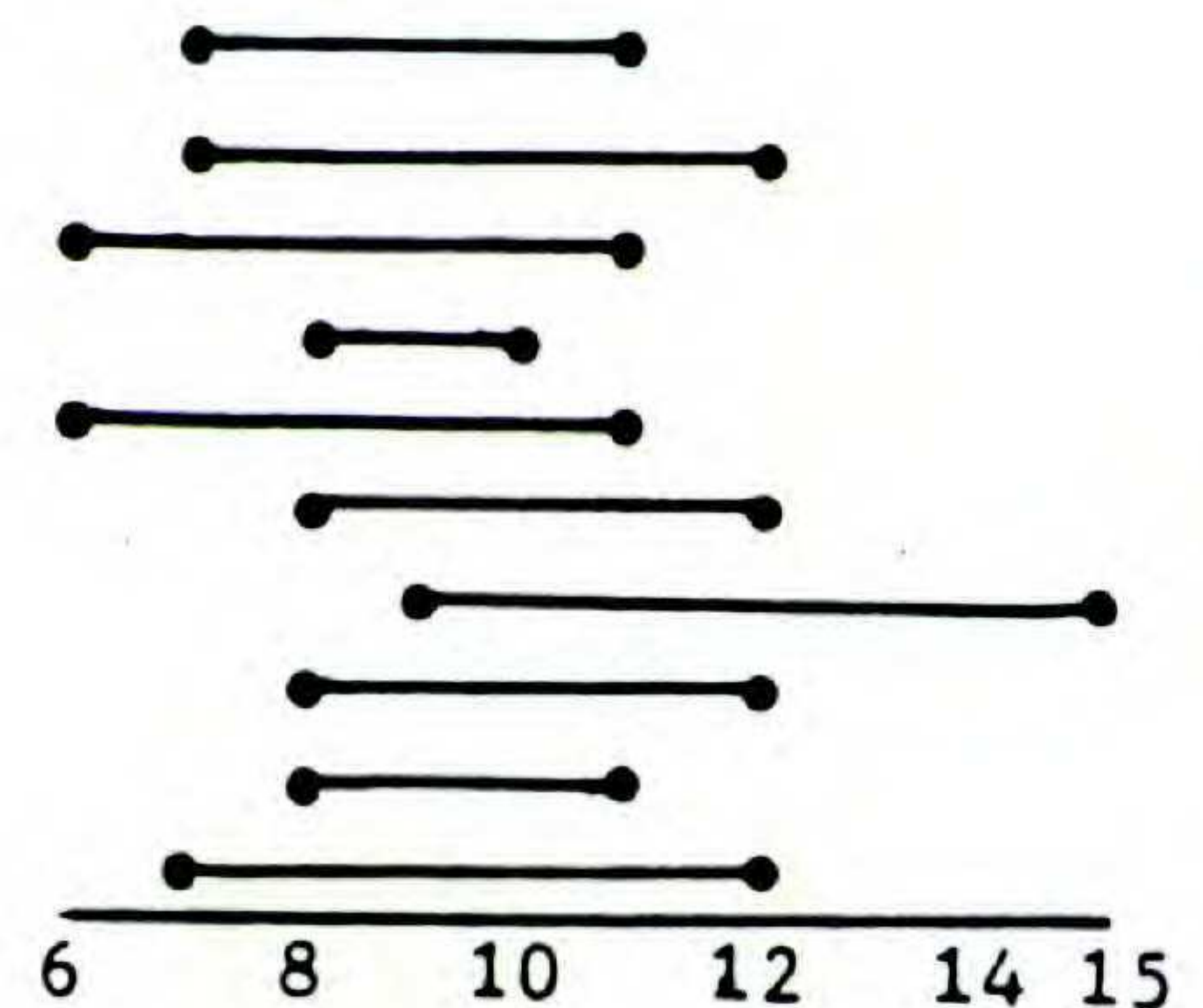


FIGURE 1. Intraspecific variation in selected characters of 11 individuals of *Pavetta rigida*.

plant appeared otherwise normal. The possible function of these nodules has been a topic of considerable interest (Lersten & Horner, 1976). To the possible functions may now be added promotion of initiation and development of increased numbers of flowers.

DISCUSSION AND CONCLUSIONS

Only 13.5/105, or ca. $\frac{1}{8}$, of the total range in numbers of flower buds per inflorescence in this geographically limited sample of *Pavetta rigida* was typically expressed in single individuals with

TABLE 3. Comparison of ranges of variation stated for *Pavetta rigida* in its original and amended descriptions and from recent field measurements on 11 individuals with total reported ranges from all three sources. Blanks mean no data available. Hiern data converted to metric units from original.

Character	Range from Hiern (1877)		Range from Bremekamp (1934)		Range from author		Total range reported
	Raw	% of total	Raw	% of total	Raw	% of total	
Number of lateral veins	10-12	30	8-11	40	6-15	100	6-15
Leaf blade length, cm ¹	12.7-21.6	25	15-24	25	14-48	96	12.7-48
Leaf blade width, cm	6.75-8.5	15	7.5-11	29	5-17	100	5-17
Leaf blade length/width ratio	2.5		2.1		2.1-3.2	100	2.1-3.2
Plant height, m	3.0-3.7	26			1.0-2.5	56	1.0-3.7

¹ Hiern leaf blade lengths obtained by subtracting petiole lengths from leaf lengths.

more than one inflorescence. This cautions against using flower number as a defining character when delimiting taxa or creating keys based on few specimens.

For vegetative characters, ca. ½ of the total range of variation of this sample of *P. rigida* was typically expressed in individuals (53% for number of lateral veins, 53% for leaf blade length, and 55% for leaf blade width). Examination of herbarium specimens may thus actually reveal less than ½ of the total range of a similar sample for these characters, and ranges of variation in leaf characters stated in descriptions based on single or few collections should perhaps be at least doubled by users of keys and descriptions to best estimate true ranges of variation. There is also significant variation among individuals in each of the other characters surveyed.

The plants examined for this study, taken from a limited geographical area, may be reproductively within the same population. They cover a minute fraction of the geographical range of the species, which has been reported from Bioko Island, Equatorial Guinea, and a fairly large portion of the forested area of Cameroon. Thus, the results of this study may still understate the actual range of variation in characters surveyed. Table 3, comparing results of this study with observations of earlier workers, indicates this to be the case for plant height.

Often keys and descriptions of tropical plants are difficult to use at species and infraspecies levels because their character state ranges do not exactly fit specimens under study. It then becomes necessary to judge whether (1) the plant at hand rep-

resents an extension in the range of a particular character state, in which case the specimen may be referred to a previously described taxon; (2) the plant represents a new taxon; or (3) the user has made an earlier error in identifying the plant. The results reported here emphasize that at least for certain quantitative characters, the first of the three possibilities is to be expected.

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